Multi-Dimensional Adsorption Model of CO2/H2O Sorbent Bed

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Abstract

The primary interest of the VC (Vacuum Characterization) test is to experimentally characterize the adsorption and vacuum desorption of CO2 and water vapor of a pelletized sorbent bed in a large diameter column. The VC test article is shown in Figures 1 and 2. The aluminum canister is 3" in diameter and approximately 8" long allowing for variable sorbent bed loads from 1" to 6" in length. A series of cylindrical breakthrough test using water vapor and nitrogen as the carrier gas were conducted previously on this test setup before any vacuum testing. The sorbent used was zeolite G522 5A.

This experimental data was used to calibrate and produce a predictive 1-D H2O adsorption breakthrough model created in COMSOL Multiphysics® software. This calibration will insure that the physics and assumptions are correct for the 2-D axisymmetric model. The objective of this simulation effort is to develop and correlate a 2-D axisymmetric adsorption/desorption COMSOL software model of the VC test article in order to capture radial effects shown in Figure 3 . A 1-D COMSOL baseline model has been created to understand the multi-physics being used during the adsorption process. This 1-D model has been successful at predicting water vapor on silica gel and zeolites and has been correlated to experimental data. However, this model only captures axial effects such as velocity, H2O and CO2 concentration and temperature gradients. The 2-D axisymmetric model captures the physics due to channeling of the carrier gas near the walls of the sorbent bed and the radially dependent porosity due to packing.

Figures used in the abstract

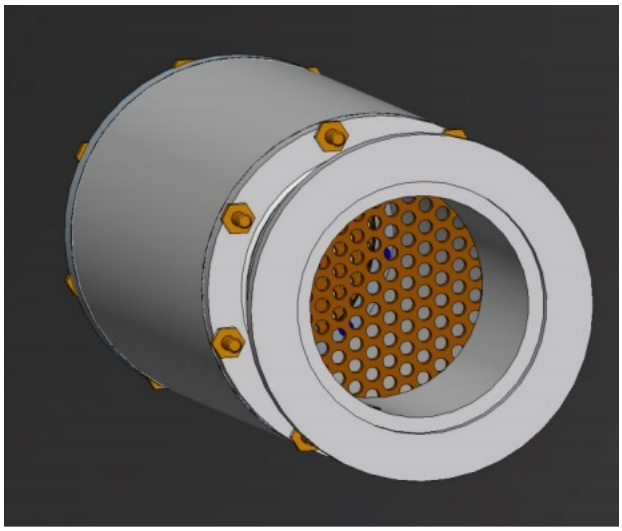

Figure 1: Vacuum Characterization test article (isometric view).

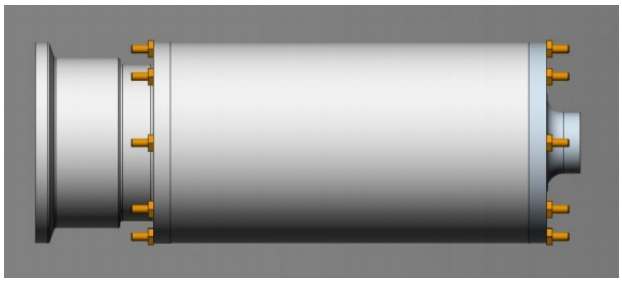

Figure 2: Vacuum Characterization test article (side view).

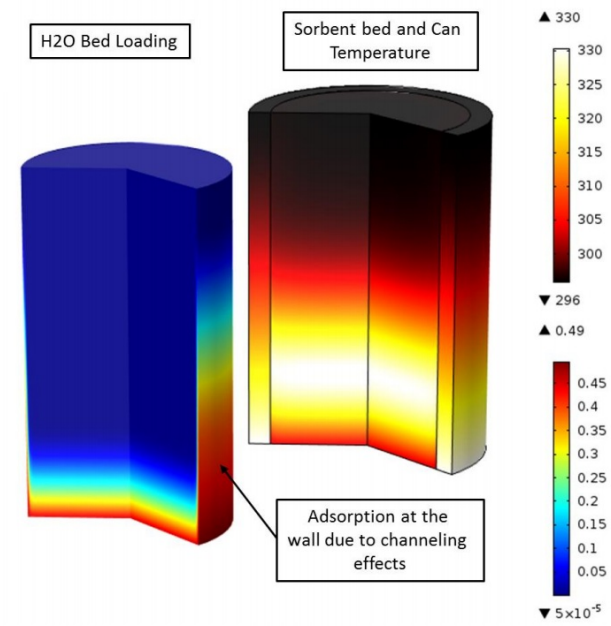

Figure 3: H2O Concentration and column temperatures at 30 seconds of the simulation.

Figure 4